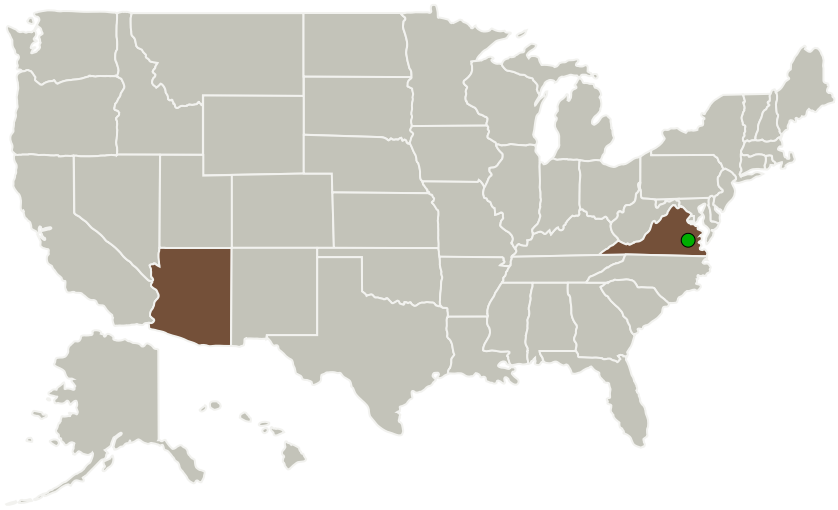
A Unified Gaskinetic Methodology for Full-Knudsen-Range Flows with Chemically Reacting Effects, Phase I

Completed Technology Project (2011 - 2011)

Project Introduction

ZONA proposes a Unified Gas Kinetic Scheme (UGKS) to cover the full Knudsen number range from the continuum flow to free molecular flow that can simultaneously exist in the jet nozzle flow of the spacecraft. In the UGKS solver, the BGK model of Boltzmann equation is solved directly with finite volume method based on the Discrete Ordinate Method (DOM). In the UGKS computation the convective terms and collision term is computed in one step with a multi-scale scheme without splitting. The UGKS also closely couples the update of macroscopic conservative variables with the update of microscopic gas distribution functions in one step. At the continuum flow regime, the UGKS recovers the Navier-Stokes solutions with much larger time step than regular direct BGK solver where UGKS essentially becomes a shock-capture scheme. In the rarefied flow regime, UGKS recovers the direct BGK method up to the free molecular flow. With the UGKS, the jet-like flow can be simulated with a unique flow solver. Furthermore, a two-species chemical reaction will be incorporated in UGKS. The UGKS will be applied to various test cases whose results will be validated with others' computational results and available experimental data to verify its accuracy and computational efficiency.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
ZONA Technology, Inc.	Lead Organization	Industry Small Disadvantaged Business (SDB)	Scottsdale, Arizona
Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Arizona	Virginia

Project Transitions

February 2011: Project Start

September 2011: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137931)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

ZONA Technology, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

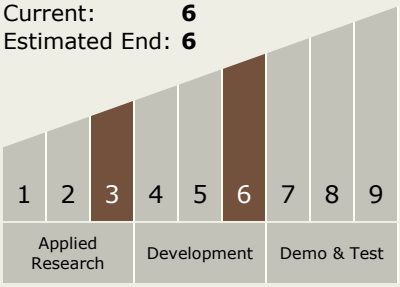
Carlos Torrez

Principal Investigator:

Shuchi Yang

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



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Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System